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Water Quality and Biological Monitoring at the Phase 2 Little Arkansas Intake Facility, 2011-13

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U.S. Department of the Interior
U.S. Geological Survey

May 2011

Presentation outline

1. Monitoring plans

Hydrobiological monitoring program agreement between USGS and City of Wichita started March, 2011

Purpose – assess biological quality of streams affected by the ASR program with initial focus on the Phase 2 intake facility

Benefits - provide information necessary to

- Design and operate facilities to best advantage of the environment
- Minimize negative effects of artificial recharge on stream quality
- Meet regulatory requirements

2. Study design and components
3. Progress
4. Protocols for data collection
5. Discussion

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Study design and components

Establish monitoring sites

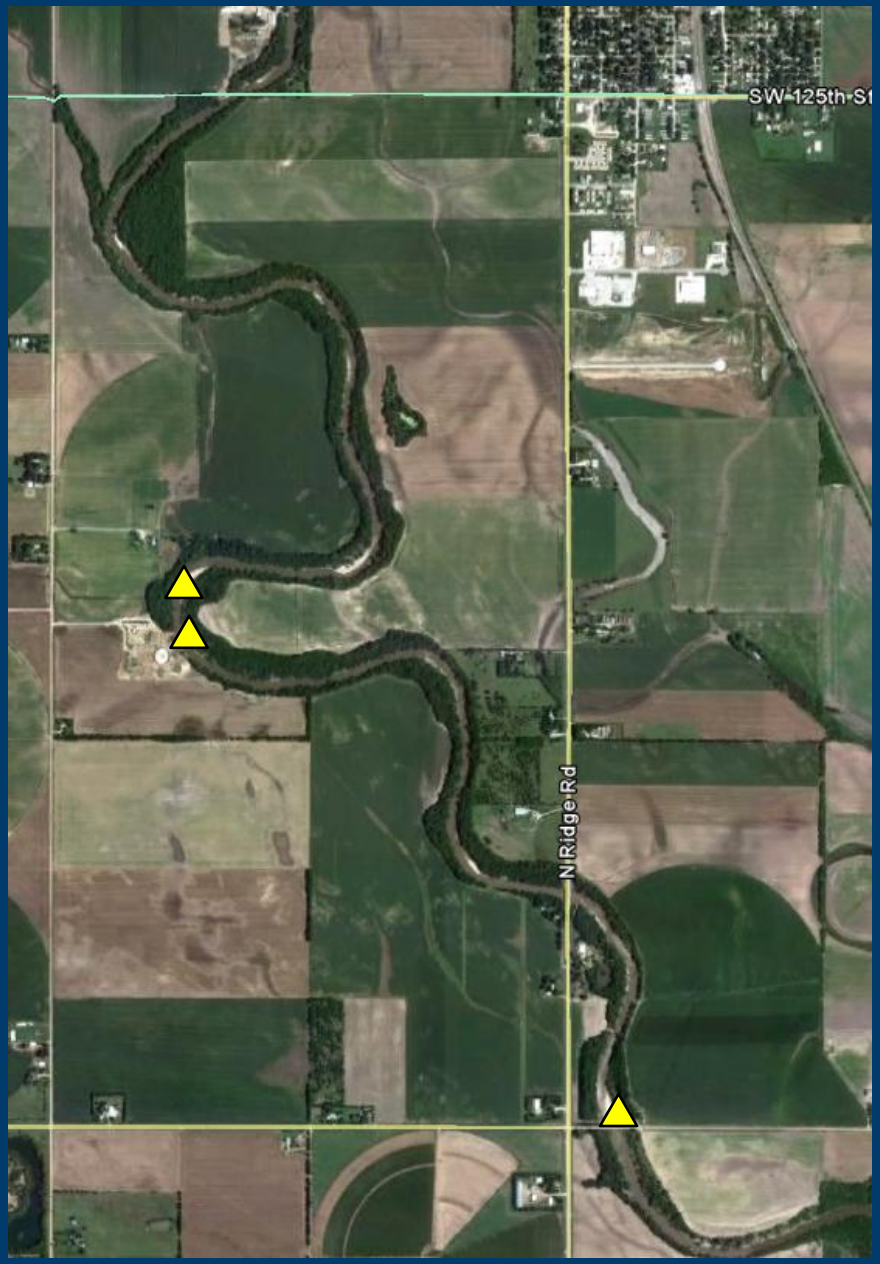
- upstream from the intake facility
- in the residual return line
- downstream from the intake facility

Implement monitoring that includes:

- Continuous water-quality and streamflow
- Water-quality samples and lab analysis
- Streambed sediment samples
- Benthic macroinvertebrate samples
- Fish surveys
- Habitat surveys

Evaluate differences between sites on the basis of:

- Water and sediment chemistry
- Macroinvertebrate and fish communities
- Riparian and in-stream habitat



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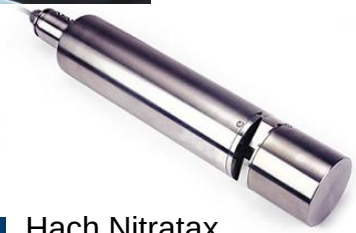
Study design and components

Continuous water-quality and streamflow

- Water temperature, specific conductance, pH, dissolved oxygen, fluorescence (chlorophyll), turbidity, optical backscatter (high turbidity, sand) at all 3 sites
- Plus UV (organic carbon) and nitrate at downstream site

YSI monitor


Hach Solitax


Hach Nitratax

Purpose

- Provide real-time information about water-quality conditions to optimize plant operations
- Increase understanding of stream variability and processes

Progress – Upstream monitor installed mid-April; downstream monitor operating except UV (organic carbon) and nitrate which have not yet been received from vendor

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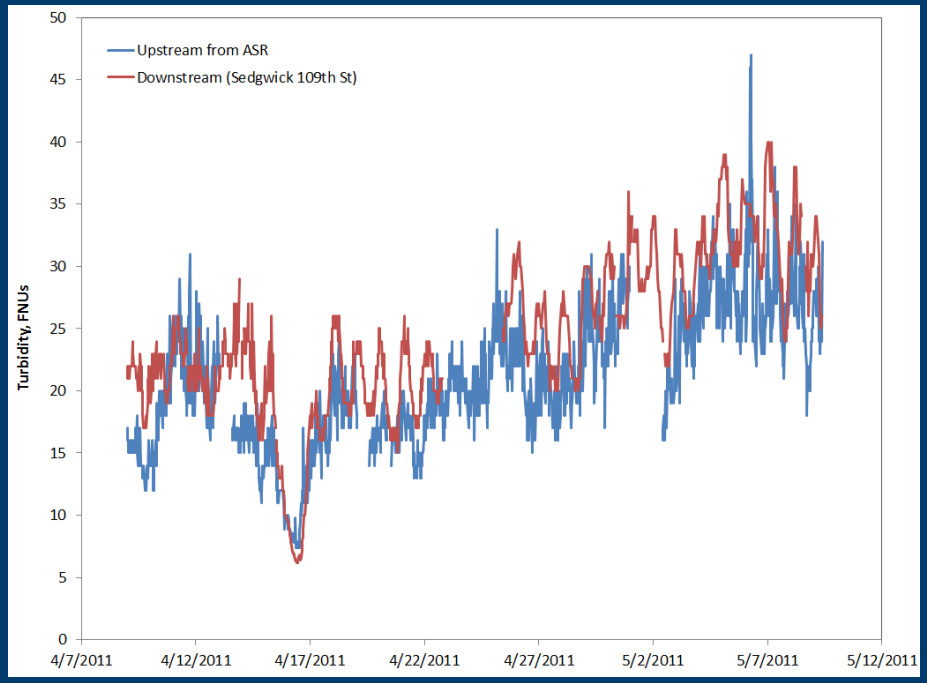
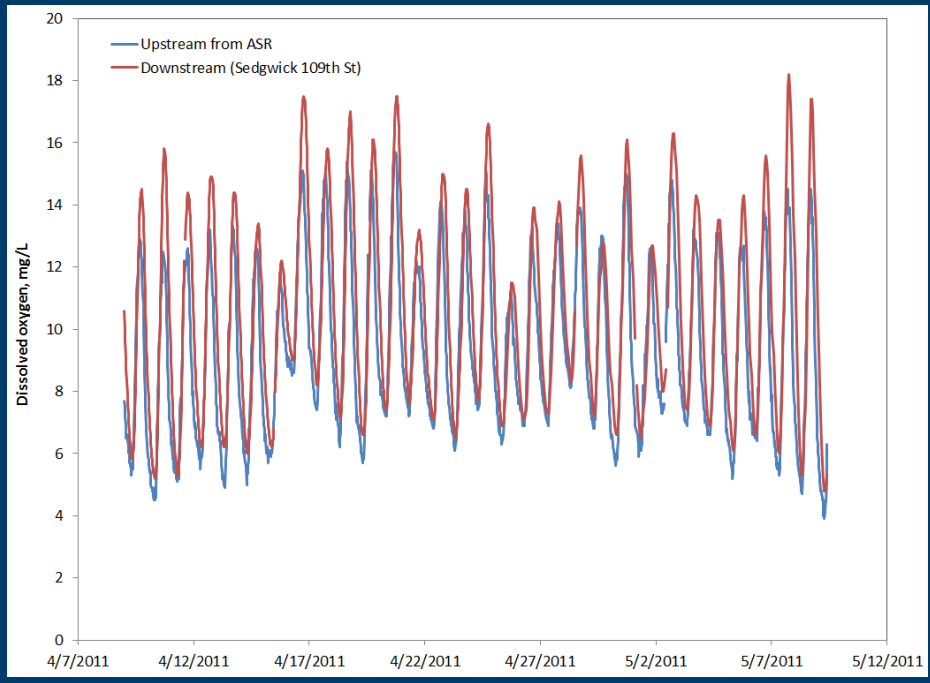
Continuous water-quality data – April/May 2011

Turbidity



Dissolved oxygen



Currently similar conditions exist at upstream and downstream sites

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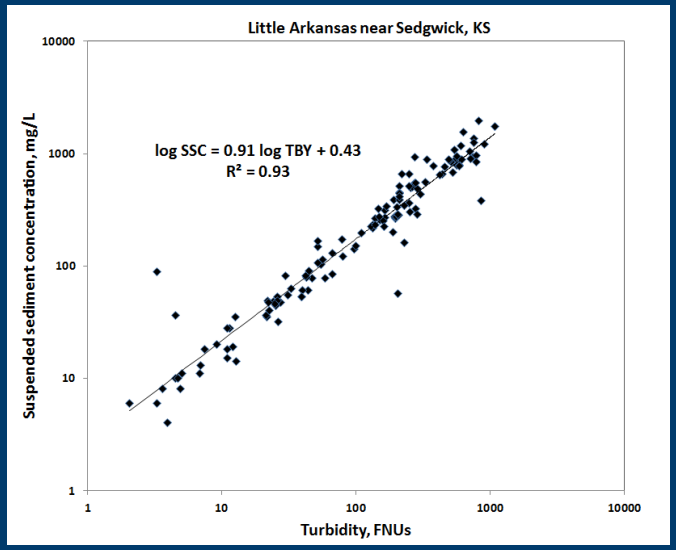

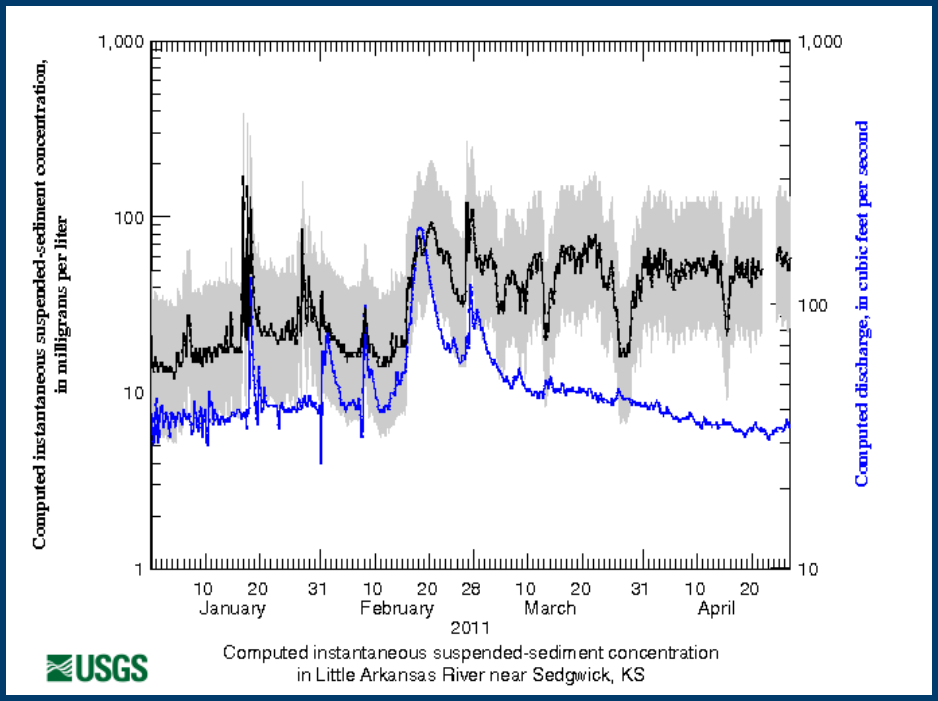

Continuous water-quality monitoring

Continuously measure streamflow and in-stream water-quality parameters

Collect discrete water samples throughout range of conditions

Develop regression models for sediment, nutrients, bacteria, other constituents of interest

Provide continuous concentrations and loads based on in-stream sensor measurements and regression models

http://nrtwq.usgs.gov/ks/

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Study design and components

Water-quality samples and lab analysis

- Collect samples monthly during different streamflow conditions
- Analysis includes nutrients, dissolved solids, major ions, suspended sediment, trace elements, indicator bacteria, pesticides

Purpose

- Provide lab analysis for many analytes during different streamflow and seasonal conditions
- Develop regression models for real-time continuous data

Progress – Water samples collected at the upstream and downstream sites in March and April; samples from return line will begin when plant operation begins

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Study design and components

Streambed-sediment samples

- Collect samples once annually in the spring
- Analysis includes nutrients, trace metals, carbon, organic compounds

Purpose

- Evaluate chemicals that accumulate in streambed sediment
- Evaluate relations between sediment chemistry and biological communities

Progress – Sediment samples collected in April from upstream and downstream sites; sediment from return line will be collected when plant operation begins

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Study design and components

Benthic macroinvertebrate samples

- Collect samples quarterly at upstream and downstream sites
- Follow KDHE sampling protocols for evaluation of aquatic-life-support status

Purpose

- Evaluate biological condition and ability to support aquatic life at stream sites

Progress – Macroinvertebrates collected from upstream and downstream sites in April

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Study design and components

Fish surveys

- Complete fish surveys annually during the summer at the upstream and downstream sites

Purpose

- Evaluate biological condition and ability to support aquatic life at stream sites

Progress – Surveys scheduled for late summer

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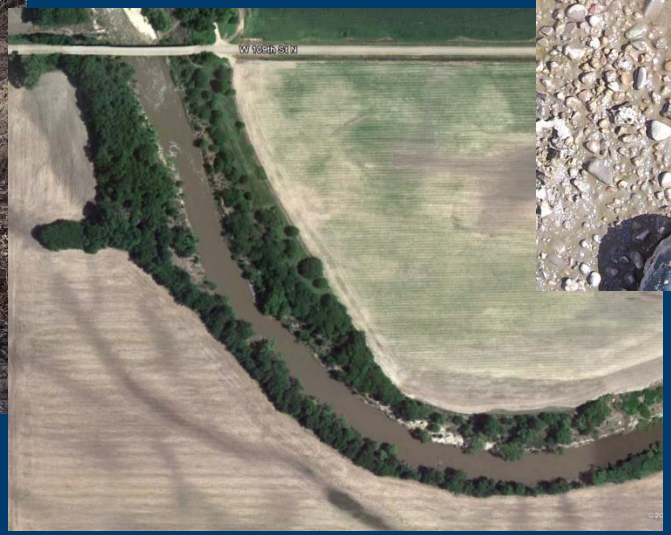
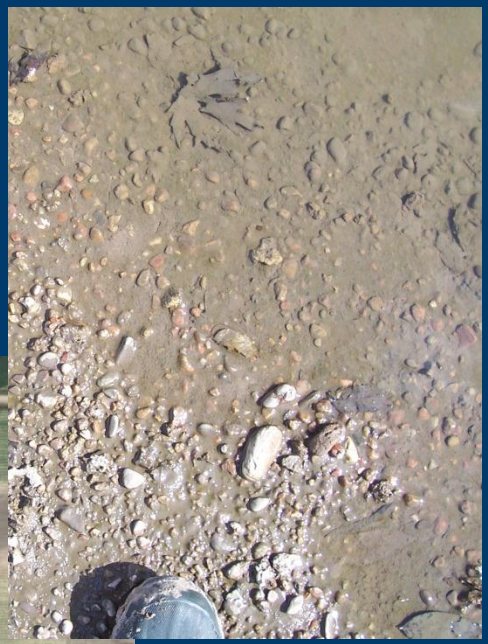
Study design and components

Habitat surveys

- Conduct surveys annually during the summer at the upstream and downstream sites





Purpose

- Identify important factors that may be affecting biological communities

Progress – Surveys scheduled to be completed during the summer

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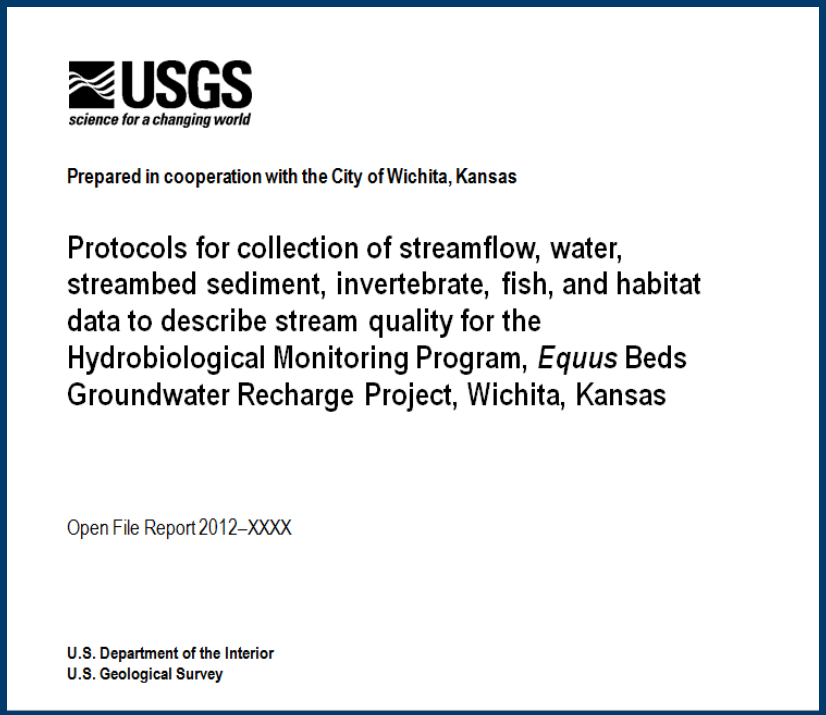
Protocol for data collection - purpose



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Prepared in cooperation with the City of Wichita, Kansas

Protocols for collection of streamflow, water, streambed sediment, invertebrate, fish, and habitat data to describe stream quality for the Hydrobiological Monitoring Program, *Equus* Beds Groundwater Recharge Project, Wichita, Kansas

Open File Report 2012–XXXX

U.S. Department of the Interior
U.S. Geological Survey

Develop a document describing field methods for collection of data

- **Streamflow**
- **Water chemistry**
- **Streambed-sediment chemistry**
- **Macroinvertebrates**
- **Fish**
- **Stream habitat**

Provide a single resource that integrates proven and accepted methods used by USGS and other agencies

Provide concise guidance for consistent collection of stream quality data

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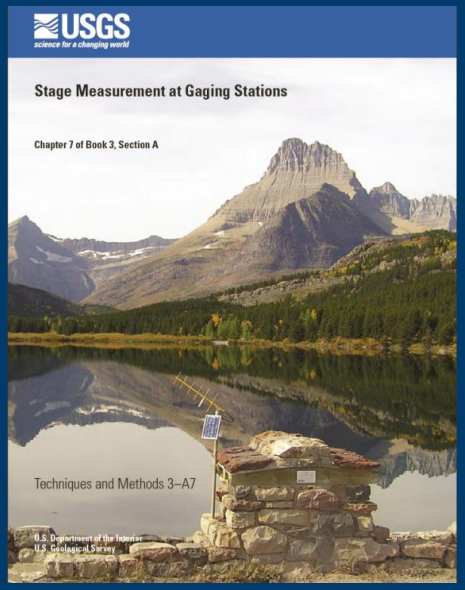

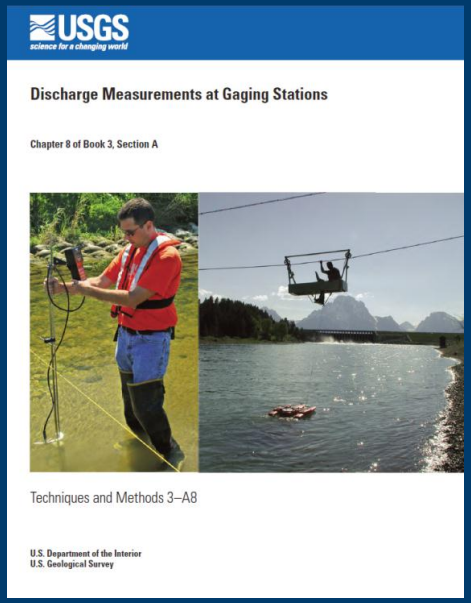

Protocol – Streamflow

U.S. Geological Survey techniques and standards

- **Stage measurements (Sauer and Turnipseed, 2010)**
- **Discharge measurements (Turnipseed and Sauer, 2010)**
- **Kansas Water Science Center Quality Assurance Plan (Putnam and others, 2008)**

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Protocol – Streamflow

Stage measurements

- Pressure transducers, radars
- Measure water-surface elevation to nearest ±0.01’
- Stage data electronically recorded and transmitted by DCP continuously
- Used as independent variable in stage-discharge relation to compute discharge
- Data verified at least monthly with measurements from a reference mark

Streamflow measurements

- Made at each station at least monthly across range of flows
- Cross-sectional area of stream determined and flow velocity measured for about 30 sections
  - wading: acoustic Doppler velocimeter
  - bridge: acoustic Doppler current profiler
- Develop stage-discharge relation
- Compute continuous discharge records for streamflow
- Ratings updated, corrections applied regularly

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Protocol – Continuous water-quality monitoring

USGS Guidelines and Standard Procedures for Continuous Water-Quality Monitors (Wagner, 2006)

Water-quality monitors

- **Temperature, dissolved oxygen, specific conductance, turbidity, pH, fluorescence, other emerging technologies**
- **Records data every 15 minutes**
- **Monitors connected to a DCP**
- **Data transmitted hourly by satellite**

Kansas Water Science Center Quality Assurance Plan (Bennett, 2003)

- **Site selection**
- **Daily review of all real-time data**
- **Cleaning and calibration at least every 6 weeks**
- **Corrections applied for environmental effects and/or instrument calibration drift**
- **Verification, public availability, and archiving of data**

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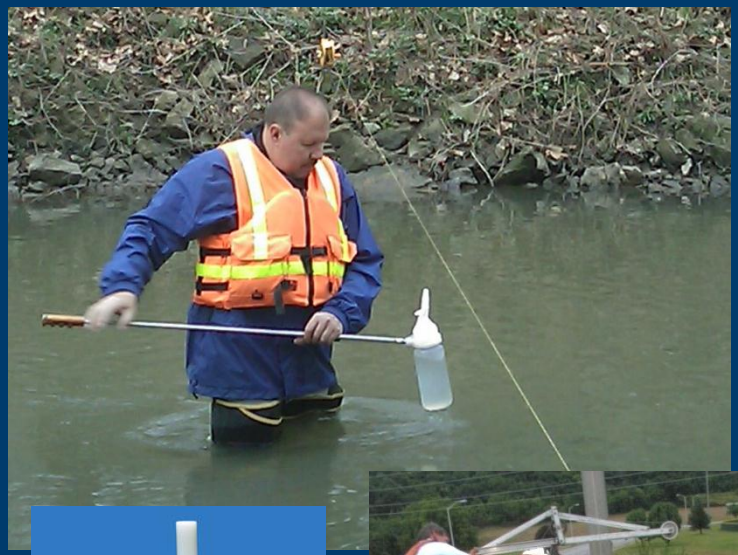

Protocol – Water-quality sampling

USGS standard procedures from National Field Manual for the Collection of Water-Quality Data (USGS, variously dated)

- Preparations for water sampling
- Selection of sampling equipment
- Cleaning of sampling equipment
- Processing of water samples

Primary objective is to obtain accurate data representative of the study system

Equal width increment

Isokinetic depth-integrating samplers

- Handheld sampler
- Cable-and-reel samplers

Acid-washed teflon bottle and churn splitter

Kansas Water Science Center Quality Assurance Plan (2009)

- At least 10 percent blanks and replicates
- Data verification and publication
- Independent lab approval
- Training, safety

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Water-quality lab analysis - Basic

Alkalinity, dissolved
Aluminum, dissolved
Ammonia, dissolved
Antimony, dissolved
Arsenate, dissolved
Arsenic, dissolved
Arsenic, dissolved
Arsenite, dissolved
Barium, dissolved
Beryllium, dissolved
Bicarbonate, dissolved
Boron, dissolved
Bromide, dissolved
Cadmium, dissolved
Calcium, dissolved
Carbonate, dissolved
Chloride, dissolved
Chromium, dissolved
Chronic whole effluent toxicity
Coliphage (viral indicator)
Copper, dissolved
Cyanide, dissolved
Dimethyl arsenate, dissolved
Dissolved organic carbon
Escherischia coli bacteria
Fluoride, dissolved
Grain size analysis (surface water only)
Hardness
Iron, dissolved
Lead, dissolved
Magnesium, dissolved
Manganese, dissolved
Mercury, dissolved
Methylarsenate, dissolved
Nickel, dissolved
Nitrate, dissolved
Nitrite plus nitrate, dissolved
Nitrite, dissolved
Orthophosphate, dissolved
Partial alkalinity, dissolved
pH
Potassium, dissolved
Selenium, dissolved
Silica, dissolved
Silver, dissolved
Sodium, dissolved
Specific conductance
Strontium, dissolved
Sulfate, dissolved
Suspended sediment (surface water only)
Suspended solids
Thallium, dissolved
Total coliform bacteria
Total dissolved solids
Total organic carbon
Total phosphorus
Total recoverable copper
Total residual chlorine
Total solids
Triazine herbicide screen, dissolved
Turbidity
Vanadium, dissolved
Water temperature
Zinc, dissolved

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Water-quality lab analysis – Pesticides and herbicides

1-Naphthol
2,6-Diethylaniline
2-Chloro-2,6-diethylacetanilide
2-Ethyl-6-methylaniline
3,4-Dichloroaniline
4-Chloro-2-methylphenol
Acetochlor
Alachlor
Aldrin
alpha-HCH
alpha-HCH-d6
Arochlor 1254
Arochlor 1260
Aroclor 1016/1242
Aroclor 1221
Aroclor 1232
Aroclor 1248
Atrazine
Azinphos-methyl
Benfluralin
beta-Endosulfan
beta-HCH
Carbaryl
Chlordane
Chlorpyrifos
Chlorpyrifos
cis-Chlordane
cis-Permethrin
Cyfluthrin
Cypermethrin
Dacthal
DDD
DDE
DDT
Deethylatrazine
delta-HCH
Desulfinylfipronil
Desulfinylfipronil amide
Diazinon
Diazinon-d10
Dichlorvos
Dicrotophos
Dieldrin
Dieldrin
Dimethoate
Endosulfan sulfate
Endrin
Endrin aldehyde
Ethion
Ethion monoxon
Fenamiphos
Fenamiphos sulfone
Fenamiphos sulfoxide
Fipronil
Fipronil sulfide
Fipronil sulfone
Fonofos
Heptachlor
Hexazinone
Iprodione
Isodrin
Isofenphos
Lindane
Malaoxon
Malathion
Metalaxyl
Methidathion
Methidathion
Metolachlor
Metribuzin
Myclobutanil
Myclobutanil
Nonachlorobiphenyl
Paraoxon-methyl
Parathion-methyl
Pendimethalin
Phorate
Phosmet
Phosmet oxon
Prometon
Prometryn
Propyzamide
Simazine
Tebuthiuron
Terbufos
Terbuthylazine
Toxaphene
trans-Chlordane
Tribufos
Trifluralin

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Protocol – Streambed-sediment sampling

National Water-Quality Assessment (NAWQA) program protocols (Shelton and Capel, 1994)

Wadeable depositional zones

- Remove top layer of sediment (about 1.0 cm)
- 5 to 10 locations per site
- Composite material in bowl
- Sieve sample < 63 micrometers
- Keep sample stored on ice
- 10 percent replicates

Rigid cleaning procedure for equipment

Avoid contamination from soaps, personal care products, caffeinated drinks, insect repellents, and other common chemicals

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Streambed-sediment analysis

Basic

Aluminum	Molybdenum
Antimony	Nickel
Arsenic	Percent moisture
Barium	Phosphorus
Beryllium	Potassium
Bismuth	Sediment bulk density
Cadmium	Sediment, grain size
Calcium	Selenium
Carbon, inorganic	Silver
Carbon, organic	Sodium
Carbon, total	Strontium
Chromium	Sulfur
Cobalt	Thorium
Copper	Tin
Iron	Titanium
Lead	Total nitrogen
Magnesium	Total phosphorus
Manganese	Vanadium
Mercury	Zinc

Wastewater Indicators

2,2',4,4'-Tetrabromodiphenyl ether	Bisphenol A-d3	4-n-Octylphenol
4-tert-Octylphenol diethoxylate (OP2EO)	Decafluorobiphenyl	4-tert-Octylphenol
4-tert-Octylphenol monoethoxylate (OP1EO)	N,N-diethyl-meta-toluamide (DEET)	Phenanthrene
Anthraquinone	Diazinon	Phenol
Acetophenone	Bisphenol A	4-Nonylphenol (sum of all isomers)
Anthracene	Fluroanthene	Tributyl phosphate
Atrazine	Indole	Triphenyl phosphate
1,4-Dichlorobenzene	Isoborneol	Tris(2-butoxyethyl) phosphate
Benzo[a]pyrene	Isophorone	Tris(2-chloroethyl) phosphate
Benzophenone	Isoquinoline	Bis(2-Ethylhexyl) phthalate
Bromacil	d-Limonene	Diethyl phthalate
3-tert-Butyl-4-hydroxy anisole (BHA)	Menthol	Prometon
Camphor	Metolachlor	Pyrene
Carbazole	Naphthalene	Sample weight, grams
Chlorpyrifos	1-Methylnaphthalene	3-Methyl-(H)-indole (skatole)
Cholesterol	2,6-Dimethylnaphthalene	beta-Sitosterol
3-beta-Coprostanol	2-Methylnaphthalene	beta-Stigmastanol
Isopropylbenzene	p-Cresol	Triclosan
Fluroanthene-d10	4-Cumylphenol	Tris(dichlorisopropyl) phosphate

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Protocol – Macroinvertebrate sampling

Kansas Department of Health and Environment stream biological monitoring plan (2000)

Sample all habitat types
- Pools/runs
- Riffles
- Overhanging roots/root wads
- Coarse woody debris

Semi-quantitative
- Timed sampling
- 2 independent 100-organism samples
- Organism removal followed morphospecies principle

Duplicate or triplicate samples

Samples sent to NWQL in Lakewood, Colorado for identification and enumeration

Laboratory QA/QC
- Within-lab cross checking of individual samples and specimens
- Repeats of identification and enumeration by different lab technicians

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Protocol – Fish surveys

USGS NAWQA protocols by Moulton and others (2002)

Select reach
- About 20 times the wetted base flow width
- Minimum length of 150 m, maximum 500 m
- Typical of the stream

Electroshocking
- Tote barge
- Downstream to upstream
- All habitats
- Flow-through holding bottle or live cage
- Two passes

Seining
- Bag and minnow seines
- Three seine collections combined

Processing
- T and E species processed first, released immediately
- Identification
- Total length (up to 30 individuals from each species)
- Total weight (using 30 individuals for total length)
- External anomalies
- Unidentifiable species preserved

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Protocol – Habitat assessment

US Environmental Protection Agency's Rapid Bioassessment Protocols (Barbour and others, 1999) and Rasmussen and others (2009)

Channel characteristics
- Flow status
- Channel slope and morphological status
- Sinuosity
- Pool status
- Riffle frequency

Streambank and riparian characteristics
- Bank stability
- Canopy cover
- Bank and riparian protection
- Length and extent of riparian zone
- Riparian zone width
- Percentage of altered banks

In-stream habitat characteristics
- Riffle substrate fouling
- Velocity/depth combinations
- Riffle substrate embeddedness
- Sediment deposition
- Diversity of epifaunal substrate and cover
- Riffle substrate composition

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Upcoming activities

- Monthly water samples during different streamflow conditions
- Additional continuous monitoring equipment
  - Dissolved organic matter
  - Nitrate
- Invertebrate collection around June and August
- Fish surveys in late August – early September
- Sediment samples from residual return line – 3 in 2011

Questions/discussion

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